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AWARDS ABSTRACT

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Electron Tubes

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HIGH-CONTRAST CATHODE RAY TUBE

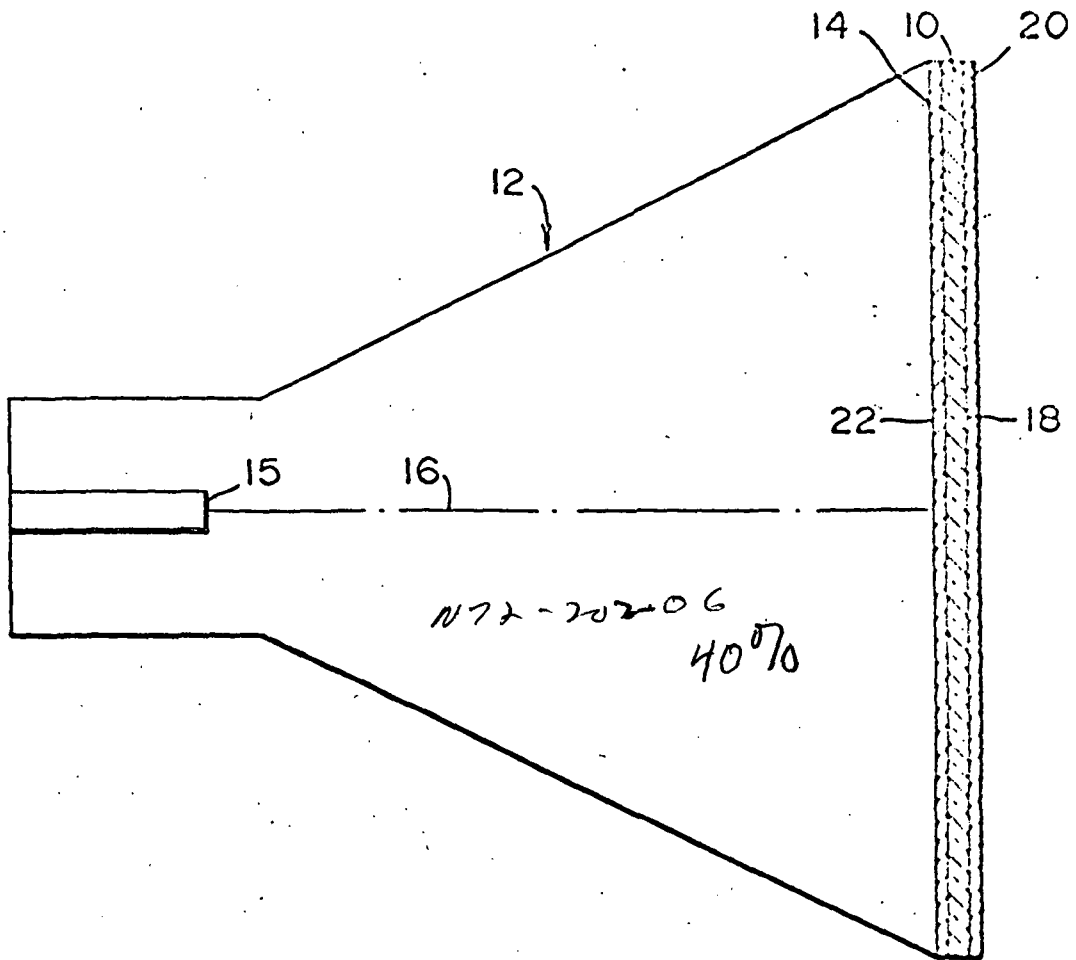
The primary object of the invention is to provide a screen for a CRT which provides high contrast and modest brightness levels, so that the CRT can be used under conditions of high ambient light.

The screen 10 (see drawing) is coated with a layer 14 which includes a mixture of cobalt oxide particules which are added to the phosphor material. The cobalt oxide absorbs a large portion of visible light directed to the CRT from the outside without materially affecting the stimulation of the phosphor to electrons 16 from an electron gun 15. Thus, greater contrast is achieved.

The primary novelty seems to reside in the use of cobalt oxide in forming a CRT screen to absorb light directed to the CRT without affecting phosphor stimulation by the tube's electrons.

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4070

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ORIGIN OF INVENTION

The invention described herein was made in the performance of work under a NASA contract and is subject to the provisions of Section 305 of the National Aeronautics and Space Act of 1958, Public Law 85-568 (72 Stat. 435; 42 USC 2457).

BACKGROUND OF THE INVENTION

1. Field of the Invention:

The present invention relates to cathode ray tubes and, more particularly, to improvements in such tubes to provide high contrast.

2. Description of the Prior Art:

A conventional cathode ray tube (CRT) is virtually useless under conditions of high ambient illumination, such as exists in cockpits or aerospace vehicles or direct sunlight. Under such conditions the tube reflects a very high percentage of incident light. The reflected light is so high that the direct emission from the tube's phosphor material becomes insignificant and, therefore, the signal is effectively lost in noise. Assuming ambient light of 10,000 foot lamberts, 80% reflectivity and direct emission from the phosphor material of 100 foot lamberts, the signal to noise ratio is 81/80.

The signal to noise ratio may be improved by high intensity electron guns which increase the direct emission from the phosphor material. However, this represents a brute force method which results in reduced tube lifetime. Thus a need exists for a CRT with high contrast and with modest brightness levels.

Such high contrast can be achieved by presenting the imagery on a relatively black background, so that high imagery brightness would not be required. Recently efforts have been directed to produce phosphor materials having black body color. However, to date no such materials are known to exist. Therefore, heretofore attempts have been made to reduce low contrast problems by employing various methods to reduce the amount of reflected energy. However, all of the known methods suffer from one or more disadvantages, characterized by increased tube complexity cost and/or reduced viewing angle.

OBJECTS AND SUMMARY OF THE INVENTION

It is a primary object of the present invention to provide a new improved CRT.

Another object of the present invention is to provide a new CRT with high contrast.

A further object of the present invention is to provide a new improved structure for use in a

CRT to provide high contrast at modest brightness levels.

Still a further object of the invention is to provide a method for producing a novel structure for use in a CRT to provide high contrast with modest
5 brightness levels.

These and other objects of the invention are achieved by providing a structure of a single layer containing a mixture of phosphor material and
10 cobalt oxide, and a method of producing such a structure which, when stimulated directly by an electron beam, provides very good contrast transfer properties under high levels of ambient light. The addition to the CRT of a front-surface non-reflection coating enables
15 the display of six shades of gray under sunlight conditions.

The novel feature of the invention are set forth with particularity in the appended claims. The invention will best be understood from the following description when read in conjunction with the accompanying
20 drawing.

BRIEF DESCRIPTION OF THE DRAWING

The drawing is a cross-sectional view of a CRT incorporating the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In accordance with the teachings of the present invention the outer screen 10, such as glass of a CRT 12 or the like, is coated internally with a layer 14 consisting of a mixture of fine grains of a phosphor material, and fine grains of a second material which is an efficient absorber of visible radiation directed thereto through the tube's screen 10 and which does not affect appreciably the stimulation efficiency of the phosphor material to electrons directed thereto from the tube's electron gun 15. The beam of electrons is designated by dashed line 16. The phosphor material is any of the well known phosphor materials presently used in CRTs, such as the various zinc sulfides or silicates. An example of the second material is cobalt oxide.

It has been discovered that when fine grains of cobalt oxide are mixed, as will be explained hereafter, with fine grains of the phosphor material, and the mixture applied to form layer 14, such a layer absorbs a large portion of visible light directed thereto from the tube's outside. Thus little visible light is reflected to an observer viewing screen 10. At the same time the cobalt oxide does not appreciably affect the stimulation of the phosphor material by the electrons. Thus, the amount of visible light which is transmitted from layer 14 through screen 10 to an observer is not appreciably affected by the cobalt oxide, whereas the

visible light which is reflected to the observer is greatly reduced. As a result a higher contrast is achieved. Alternately stated, for a given tube brightness level the use of the novel layer 14 results in a higher signal to noise ratio than that attainable with a conventional phosphor material layer which does not contain the second material, such as cobalt oxide. Hereafter the second material will be referred to as cobalt oxide.

10 Layer 14 is formed by producing a suspension of fine grains of the selected phosphor material and of cobalt oxide in an evaporable liquid which does not dissolve either the phosphor material or cobalt oxide. The suspension is then applied to the screen 10 by
15 either spraying or other coating methods. Then, when the suspension liquid evaporates, a hardened layer 14 is formed. Preferably, a small amount of liquid, which facilitates the deposition and the adhesion of the suspension to the screen, should be added prior to
20 the deposition step. Actual reduction to practice indicates that water is a very adequate liquid for the suspension of the fine grains of the two materials, while the addition of alcohol facilitates the spraying and adhesion of the suspension to the screen.

25 In each of several applications, actually reduced to practice, the selected phosphor material was ball-milled with water and stones in a quart cork

for an extended time period, e.g., 18 hours. The liquid portion was then decanted into a jar and allowed to settle until only particles not greater than a desired size remained suspended in the water. The supernatant
5 containing the fine phosphor particles was siphoned off. Cobalt oxide was then added to the supernatant which was again ball-milled, decanted and again allowed to settle until only particles or grains not larger than a desired size remained suspended. It
10 is this supernatant which is sprayed or otherwise coated on the screen 10 to form layer 14. As previously pointed out alcohol can be added to the final supernatant to facilitate spraying and adhesion to the screen.

It has been found that improved efficiency
15 is realized by coating the outer surface 18 of screen 10 with an anti-reflection coating material 20, such as MgF, and by aluminizing the exposed surface 22 of layer 14 to improve heat dissipation at high beam currents.

20 Among various layers actually reduced to practice to date, all of which provided various significant degrees of improved efficiency over the prior art, one provided superior results. It comprised P-1 phosphor material milled and elutriated with Co_3O_4 ,
25 sprayed on the screen to yield 12% transmission to 2870°K light, with the layer's exposed surface aluminized. When employed in a CRT with a commercially available

focus gun such as 8HPE-S and a 2"x2" useful display, the screen provided a line brightness of about 600 foot-lamberts at 6000" per second with a gun operated at 5000 microamperes at 16KV. The reflectivity was
5 7.5%, 4% of which were attributed to the uncoated screen faceplate. The efficiency in terms of lumens/watt was about 20.

Although heretofore cobalt oxide was generally referred to as the material added to the phosphor
10 material to produce the novel useful and unforeseen results it is to be understood that other materials may be substituted. The characteristics of each such material are the property of absorbing visible light directed thereto through the screen, while at the
15 same time not materially affecting the phosphor stimulation to electrons from the electron gun. Also, the material should be one which does not dissolve in the liquid in which the phosphor grains are suspended and that it not react with the particular phosphor
20 material used, such as zinc sulfide.

Although a particular embodiment of the invention has been described and illustrated herein, it is recognized that modifications and variations may readily occur to those skilled in the art and
25 consequently it is intended that the claims be interpreted to cover such modifications and equivalents.